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(71) Applicant *(for all designated States except US):* CASSEL-SMITH LIMITED [GB/GB]; 21 Park View Close, Allestree, Derby DE3 2GH (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only) :* SMITH, Edwin, James [GB/GB]; 21 Park View Close, Allestree, Derby DE3 2GH (GB).

(74) Agent: OVERBURY, Richard, Douglas; Haseltine Lake & Co., Hazlitt House, 28 Southampton Buildings, London WC2A 1AT (GB).

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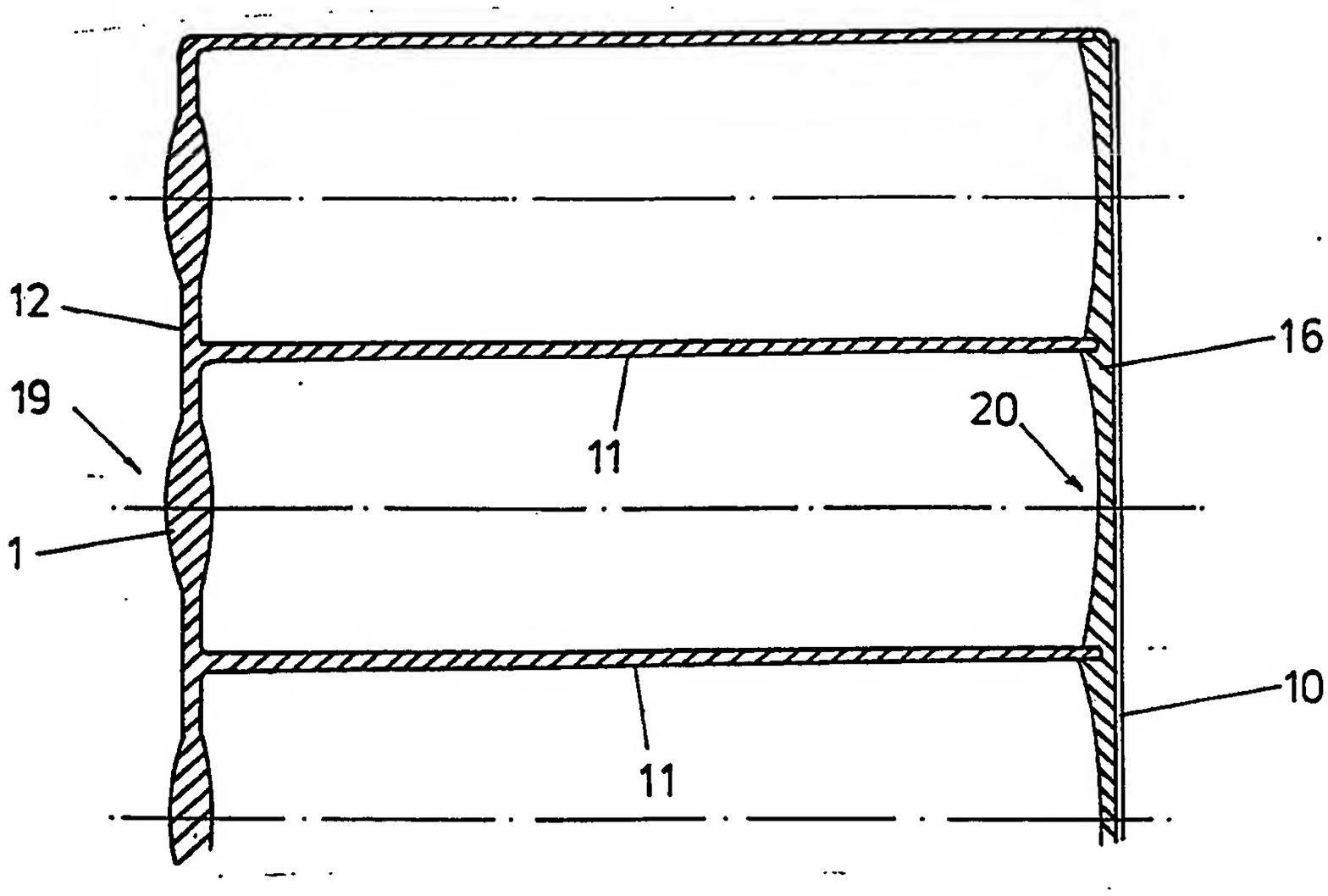
(54) Title: A SIGN READABLE AT SPEED



(57) Abstract

A sign comprises an array of elements each comprising a first lens (1), a second lens (16, 17, 21), and an optical object (10) in registry with the first and second lenses such that the virtual image of the optical object formed in the second lens lies in the focal surface of the first lens. The optical objects consist of a representation of the information which the sign is to present. The image of the optical objects seen by a viewer moving past the sign appears to be stationary with respect to the viewer.

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A SIGN READABLE AT SPEED

The present invention relates to a sign readable at speed and is concerned with such a sign which, for example, is suitable for location by the side of a railway track for presenting information to a viewer of the sign travelling along the track.

United States Patent Specification No.3,568,346 discloses an optical sign of this type in which the functional assembly of the sign comprises an array of hexagonal or rectangular spherical biconvex lenses of positive power, and a corresponding tessellated array of identical optical objects, each object being disposed in the focal plane of the corresponding lens and being a representation of the information which the sign is to present. However the use of spherical biconvex lenses is disadvantageous due to spheric aberrations.

In order to reduce spheric aberrations British Patent Specification No.2,149,527 provides an optical sign comprising hexagonal or rectangular lenses which are aspheric and optionally may be of the equivalent fresnel design. The optical object corresponding to each lens is disposed on a hexagonal sheet that conforms to the contour of the focal surface of the lens and is concave with respect to the front of the sign.

However providing the optical object on a surface which conforms to the focal surface of the aspheric lens is difficult.

Accordingly the present invention provides a sign for presenting information to an observer moving with respect thereto, which sign comprises a plurality of elements linearly disposed with respect to one another, each of which elements comprises first and second coaxial lenses and a planar optical object

consisting of a representation of the information which the sign is to present and in registry with said first and second lenses, the optical objects of the elements being substantially identical and said first lens constituting the external surface of the sign, wherein the virtual image of the planar optical object formed by said second lens of each element lies in the focal surface of the first lens of the element such that light rays emanating from any point on the optical object through the second lens emerge in a substantially parallel manner from the first lens.

By "substantially identical" optical objects there is meant identical optical objects or optical objects which differ cinematically from one another so that an animated image is presented to the moving viewer.

In a first embodiment of the invention the first lenses are aspheric and the second lenses are plano-concave lenses wherein the plane surfaces of the plano-concave lenses are most remote from said first lenses and the optical objects lie directly against said plane surfaces of said lenses.

In a second embodiment of the invention the first lenses are aspheric and the second lenses are fresnel lenses of negative power in which the fresnel grooves are formed in the surface nearer to the first lenses, the objects being mounted at a fixed distance from the second lenses, in the direction away from the first lenses.

In a third embodiment of the invention the first lenses are surrounded by an opaque diaphragm, defining apertures which are coaxial with the lenses, such that the functional area of the lens is reduced. Where the first lenses are hexagonal aspheric lenses, the diaphragm may define hexagonal apertures, which

apertures may be displaced by 30°, with respect to their associated lens, about their common axis. The functional area of the lens may be reduced such that it corresponds with the area of the aperture.

In a fourth embodiment of the invention, the first lenses may comprise fresnel lenses.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 is a partially sectioned front view of one type of known optical sign,

Figure 2 is an end view of the sign of Figure 1,

Figure 3 is a perspective view of a part of another type of known optical sign,

Figure 4 is a section through a first sign in accordance with the present invention,

Figure 5 is a section through a second sign in accordance with the present invention,

Figure 6 is a section through a third sign in accordance with the present invention,

Figure 7 is a front view of the sign of Figure 6,

Figure 8 is a section through a fourth sign in accordance with the present invention,

Figure 9 is a section through a rear portion of a fifth sign in accordance with the present invention, and

Figures 10, 11 and 12 diagrammatically illustrate the theoretical principles of the present invention.

In the various Figures, corresponding parts are denoted by like reference numerals.

Referring to Figures 1 and 2 there is shown an

optical sign as disclosed in United States patent 3,568,346. The sign contains light sources 3 and a light diffuser 4 which uniformly illuminate the functional assembly forming the front of the sign. The sign comprises a tessellated array of hexagonal spherical biconvex lenses 1 of positive power, and a corresponding tessellated array of identical optical objects 2, each object 2 being disposed in the focal plane of its corresponding lens. The lenses and objects 2 are each arranged in contiguous columns, adjacent columns being vertically offset as shown in Figure 1. The objects 2 are printed on a flat transparent sheet 10 so as to be illuminated by the light sources 3 via the diffuser 4 on which the object sheet 10 is mounted. The areas of the object sheet which surround the optical objects are opaque.

The lens-object pairs are separated from one another by opaque hexagonal partitioning (not shown) resembling a honeycomb. The partitioning divides the sign into an array of elements, each element being bounded by a lens 1, its corresponding object 2 and the adjacent partitioning. The lens array, partitioning, object sheet 10 and diffuser 4 are supported and held in alignment within the box 5 by supports 6. The top of the box 5 is closed by lid 9. The supports 6 are screwed to anchor nuts 7 which in turn are attached to plates 8 welded to the bottom and sides of the box 5.

The single image seen by a viewer positioned in front of the sign is identical to each of the duplicated objects, appears to be large and distant, and is stationary relative to the viewer, that is it moves with the viewer, irrespective of his movements in relation to the sign.

The columns of optical objects may be arranged in groups, the groups differing cinematically so that

an animated image is presented to a transversely moving viewer.

In Figure 3 is shown a cutaway view of the sign of GB 2,149,527, in which hexagonal lenses 1 are aspheric and optionally of the equivalent fresnel design. The optical object 2 corresponding to each lens 1 is disposed on a hexagonal sheet that conforms to the contour of the focal surface of the lens and is concave with respect to the front of the sign. The concave sheets tessellate to form a continuous sheet. The lens-optical object pairs are separated by opaque partitioning 11.

Referring to Figure 4, there is shown a sign according to the invention which sign comprises an array of plano-concave second lenses 16, each disposed coaxially with the first lens 1 of its element and with its plane surface towards the back of the element. Each optical object (not shown) is printed on flat transparent object sheet 10 mounted directly on the plane surface of the plano-concave lenses. The function of the lenses 16 is to correct for curvature of the focal surfaces of first lenses 1. Each lens 16/object assembly is positioned coaxially in relation to the aspheric first lens 1, such that the virtual image of the object produced by lens 16 lies on the focal surface of lens 1. Thus rays passing through any point on any one of the co-planar objects constituting the information presented by the sign, and also passing through the aspheric first lens 1, emerge parallel within acceptable limits. Since the axes of the other identical elements forming the array are parallel, the rays from all points on the corresponding optical objects emerge parallel giving the illusion of an image at infinity, that is, beyond the discriminatory power of binocular stereoptic vision. Thus, the information

presented by the sign appears to be stationary to a viewer moving past the sign. The sign includes a light source (not shown) similar to source 3 of Figures 1 and 2.

Figure 5 shows another embodiment of the invention wherein each element includes a second lens in the form of a fresnel lens of negative power 17, having the fresnel grooves formed in its front surface, that is, the surface nearer to the first lens 1. The object sheet 10 is mounted on a separate transparent object sheet support 18 set at a fixed distance from the negative fresnel lenses 17. The powers of the first and second lenses of each element and the axial positions of the lenses and the optical objects on sheet 10 are such that rays passing through any point on any one of the co-planar objects constituting the legend, and also passing through the negative fresnel lens 17 and the aspheric first lens 1, emerge parallel. Again the sign includes a light source (not shown).

Figures 6 and 7 show a modification of the embodiment of Figure 4 wherein the front of each element is covered by an opaque diaphragm 12 which reduces the effective area of the first lenses 1. The lenses 1 can be reduced in area so that their functional area corresponds to the area of the apertures. The diaphragm 12 comprises an opaque sheet, mounted on the front surface of the lenses 1 in which is formed a series of apertures 13. Each aperture 13 is hexagonal, concentric with its element's axis and rotated about its axis through 30 degrees with respect to boundary 14 of its first lens.

The shape and proportions of the diaphragm 12 are such that when the array of elements is considered as a whole, horizontal lines 15 drawn across the face of the sign coincide with the apertures 13 for a fixed

proportion of their lengths. In Figure 7 the apertures 13 and the lens boundaries 14 are regular hexagons whose sides are in the proportion of $\sqrt{3}$:1 and whose areas are therefore in the proportion of 3:1. It will be seen that any horizontal line 15, drawn across the face of the sign, will coincide with the apertures 13 for one third of its length. Because of the persistence of vision on the retina of the eye, the image seen by a viewer travelling horizontally with respect to the sign, at a speed of the order of 40 columns of elements per second, appears to be stable and uniformly illuminated. Furthermore the resolution of the observed image is enhanced when the effective areas of the individual lenses are decreased by the diaphragm.

Figure 8 illustrates a modular method of constructing a sign according to the invention. Each module consists of a convenient number of elements integrally formed in a tessellar box-like construction comprising two mating components manufactured in a refracting medium such as clear acrylic plastic. The modules tessellate so that they can be assembled into a transparent facia to form a continuous assembly of any required size. The front component 19 of the module comprises the first lenses 1, diaphragm 12 and partitioning 11 of the constituent elements, the said diaphragm and partitioning being coated with an opaque medium. Only the functional areas of the first lenses need be incorporated in the front component 19. The rear component 20 comprises the plano-concave second lenses 16, and its rear flat surface incorporates means, such as spigots and fixings, to support and positively locate the object sheet 10. A source of illumination (not shown) is included in the sign.

A variant of this modular construction in

which the plano-concave second lenses 16 are replaced by fresnel lenses of negative power is shown in Figure 9. The lenses are formed in a continuous sheet 21 interposed, and positively located between, the front component 19 and the rear component 20 with its fresnel grooves facing the front component 19. This rear component 20 consists mainly of a flat transparent sheet of constant thickness on which the optical sheet 10 is supported and positively located.

Figures 10 to 12 show the relationship between the design parameters of an individual element forming part of the functional assembly of the sign, and the performance of the complete sign. Figure 10 shows a vertical section through a single element, while Figure 11 shows an end view of the complete sign similarly orientated and drawn to a much smaller scale.

In the element shown in Figure 10, an optical object, extending from M_{22} to N_{22} is positioned in the focal plane of lens 1, the element being optically segregated from adjacent elements by partitioning 11. For clarity the second lens at the rear of the element is omitted; in the following description, the terms focal plane and optical object refer to the virtual image of the optical object produced by the second lens. Similarly the lens 1 is assumed to be a thin aspheric fresnel lens of positive power with an optical centre P and a back focal length PF where F is the point of intersection between the element axis and the focal plane. Rays radiating from any point on the optical object and passing through lens 1 are assumed to emerge parallel from the front of the sign.

For comparison two alternative optical objects 22 and 23 are identified in the focal plane. Object 22 extends from M_{22} to N_{22} and object 23 extends from M_{23} to N_{23}. Thus the ray $M_{22}P$ passes through the upper

extremity M_{22} of object 22 and the lens centre P and then emerges without refraction as PX. Rays $M_{22}S$ and $M_{22}T$ pass through the upper and lower extremities of the lens and emerge after refraction as rays SW and TY respectively, both parallel to PX. Similar parallel rays can be drawn for any point on the optical object.

In Figure 11 the complete sign 26 is shown in which the facia 25 represents a tessellated array of the first lenses of the elements. The points P of all these aspheric lenses lie in this plane. A vertical section through the zone in which object 22 is visible, hereinafter called 'viewing zone 22', is delineated by drawing GQ_{22} parallel to line $M_{22}P$ and HQ_{22} parallel to $N_{22}P$. $M_{22}PN_{22}$ and $GQ_{22}H$ are similar triangles and $GQ_{22}H$ is a vertical section through viewing zone 22. Any viewer whose pupils lie within this zone can observe a complete image of optical object 22. By way of example, the image of optical object 22 is seen by a viewer V1 through part of the facia DE where DV_1 is drawn parallel to GQ_{22} and EV_1 is drawn parallel to HQ_{22}.

Similarly in Figure 10 the lesser object 23 occupies a part $M_{23}N_{23}$ of the optical object plane. In Figure 11 viewing zone 23 is delineated by drawing GQ_{23} parallel to $M_{23}P$ and HQ_{23} parallel to $N_{23}P$, $GQ_{23}H$ being a vertical section through the zone. It follows that a viewer V_2, whose pupils are within viewing zone 23 but are outside of viewing zone 22, can observe a complete image of optical object 23 but only a partial image of optical object 22.

It will be seen that for a given optical object, the relationship between the maximum viewing distance, facia height, lens focal length, and optical object height is expressed by the formula:

$$\frac{\text{basic facia height}}{\text{maximum viewing distance}} = \frac{\text{optical object height}}{\text{focal length}}$$

The basic facia height necessary to achieve a given maximum viewing distance can be calculated as follows:

Given: maximum viewing distance 3200 mm
focal length 125 mm
optical height 50 mm

$$\text{basic facia height} = \frac{3200 \times 50}{125} \text{ mm}$$

$$= 1280 \text{ mm}$$

In practice an allowance is made for eye-level variation as shown in Figure 12. To allow for eye-level variation 1 at the maximum viewing distance this dimension is added to 42, the basic facia height, to give a total height 43.

In the foregoing example the basic facia height is 1280 mm. If an eye level variation of 220 mm is required at the maximum viewing distance, this dimension must be added to the basic facia height giving a total height of 1500 mm.

In most applications in which the optical object is to be observed by a viewer moving horizontally with respect to the sign, the viewing distance is limited by the height of the facia. The duration of the observed image is determined by the time taken for the viewer's pupils to pass horizontally through the viewing zone, which in turn depends upon the horizontal length of the sign and the viewer's passing speed.

CLAIMS:

1. A sign for presenting information to an observer moving with respect thereto, which sign comprises a plurality of elements linearly disposed with respect to one another, each of which elements comprises first and second coaxial lenses and an optical object consisting of a representation of the information which the sign is to present and in registry with said first and second lenses, the optical objects of the elements being substantially identical and said first lens constituting the external surface of the sign, wherein the virtual image of the optical object formed by said second lens of each element lies in the focal surface of the first lens of the element such that light rays emanating from any point on the optical object through the second lens emerge in a substantially parallel manner from the first lens.

2. A sign as claimed in claim 1 wherein the first lens of each element is an aspheric hexagonal lens.

3. A sign as claimed in claim 2 wherein the second lens of each element is a plano-concave lens, the plane surface of which is most remote from the first lens of the element and wherein the optical object lies directly on said plane surface.

4. A sign as claimed in claim 2 wherein the second lens of each element is a fresnel lens of negative power and having fresnel grooves formed in its surface nearer to the first lens of the element and wherein the optical object of each element is mounted at a fixed distance from said second lens in the direction away from said first lens.

5. A sign as claimed in claim 2 wherein the first lens of each element is partially covered by an opaque diaphragm defining an aperture coaxial with the lens.

6. A sign as claimed in claim 5 wherein each

aperture is a hexagonal aperture which is displaced by 30° with respect to the first lens, about their common axis.

7. A sign as claimed in claim 1 wherein the first lens of each element is a fresnel lens.

8. A sign as claimed in claim 1 wherein the sign includes a light source by means of which the optical objects are illuminated.

9. A sign as claimed in claim 1 wherein the elements comprise a tessellated array.

10. A sign as claimed in claim 9 wherein opaque partitions are located between adjacent elements.

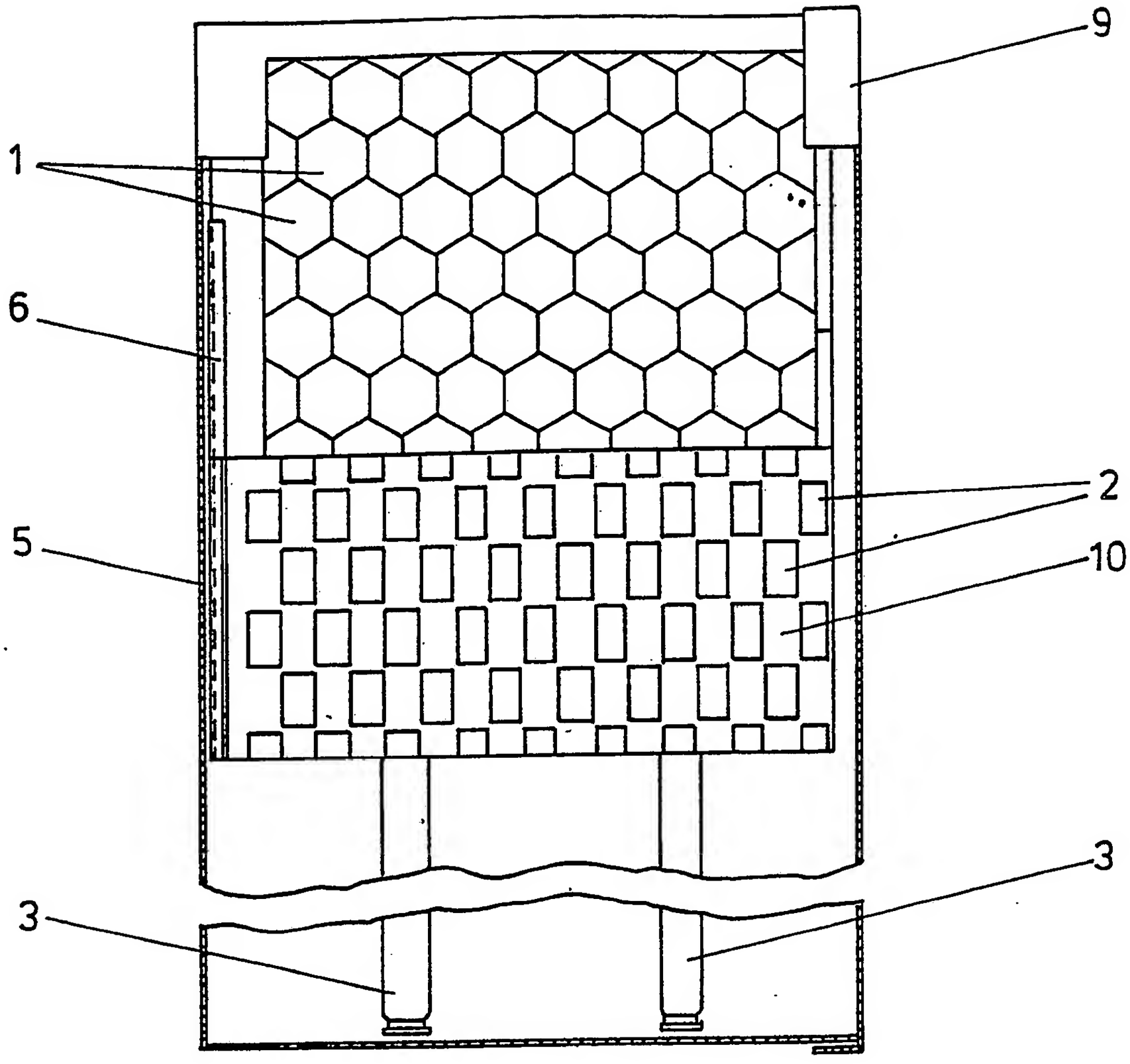

FIG. 1

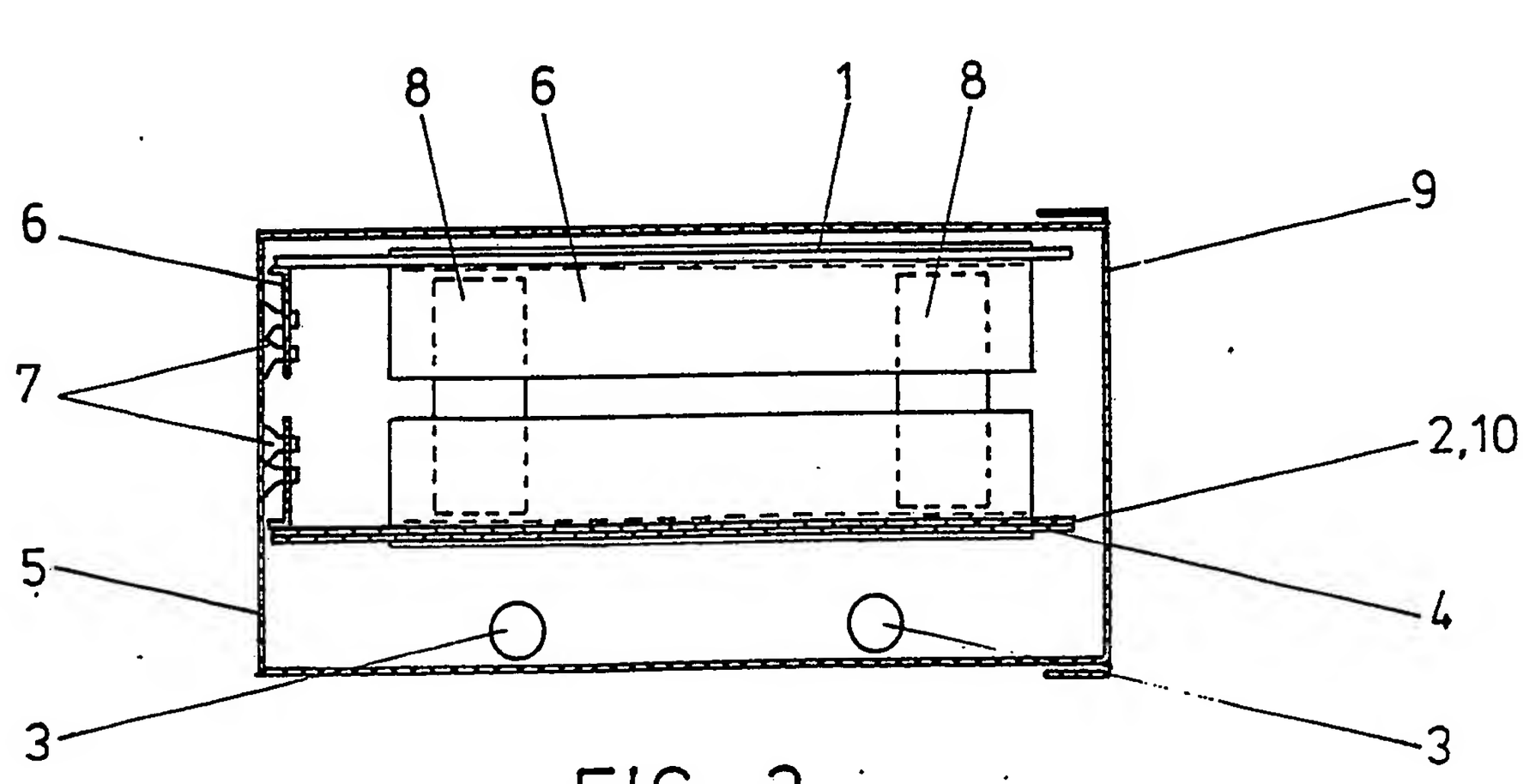

FIG. 2

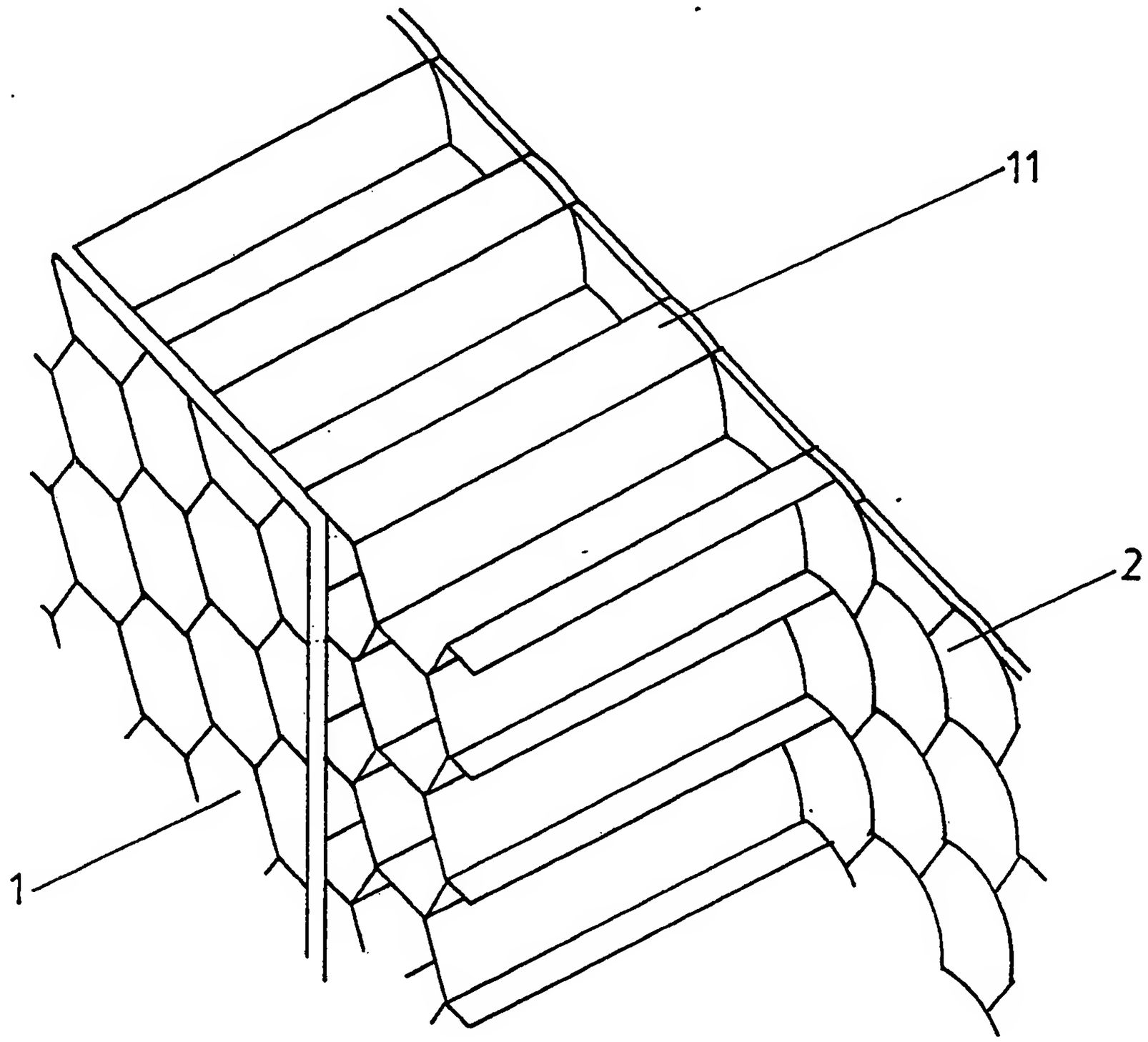

FIG. 3

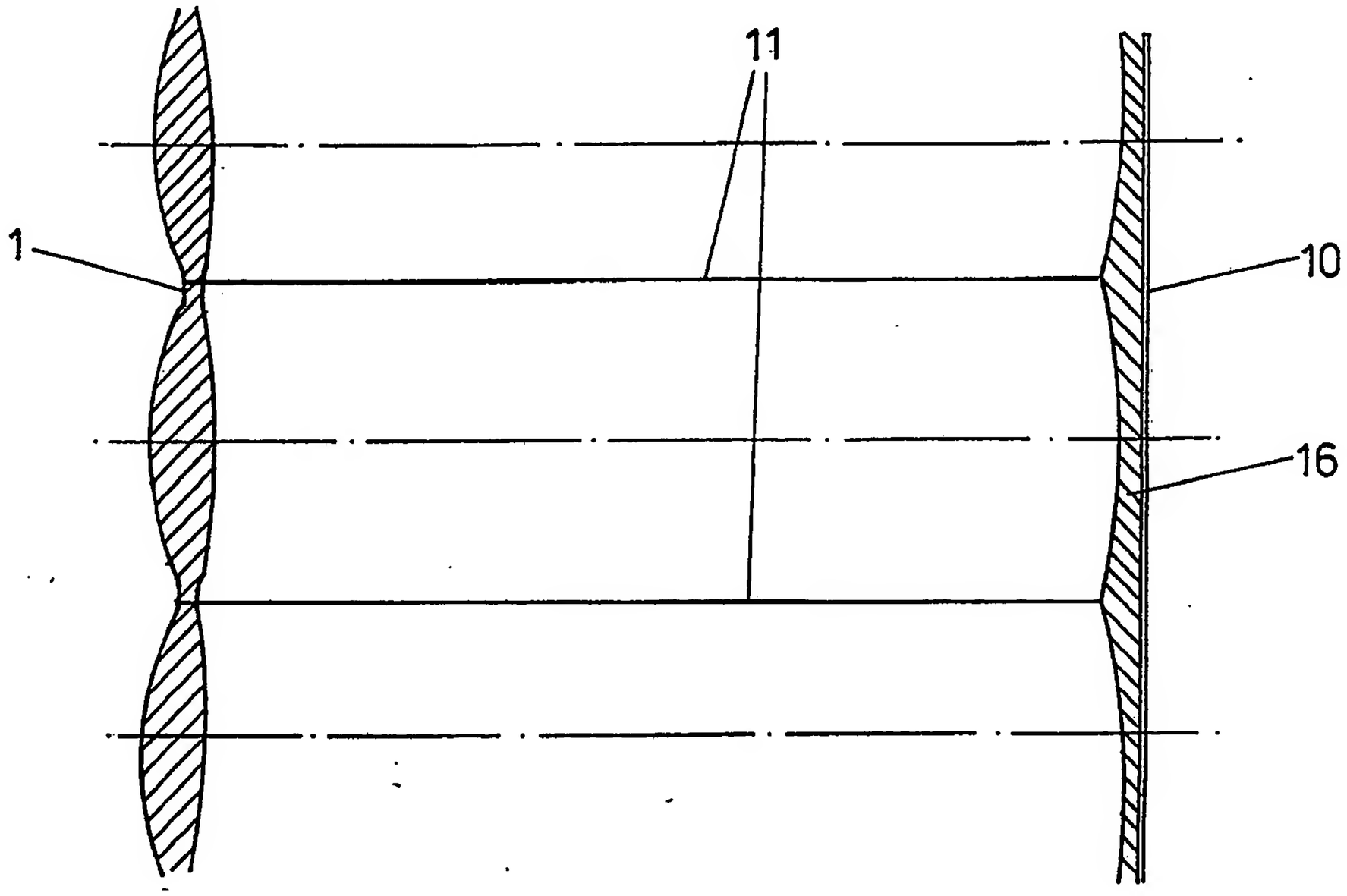

FIG. 4

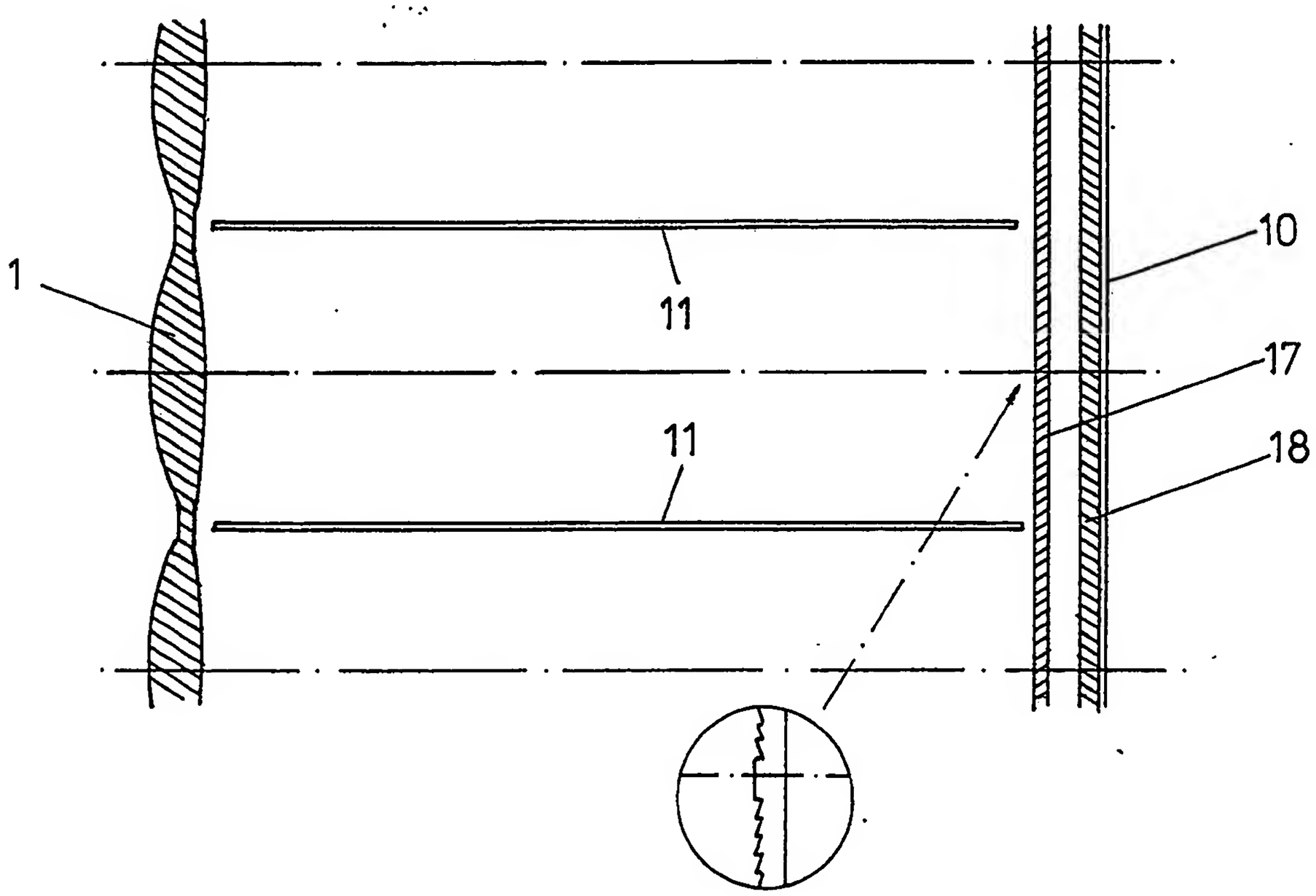

FIG. 5

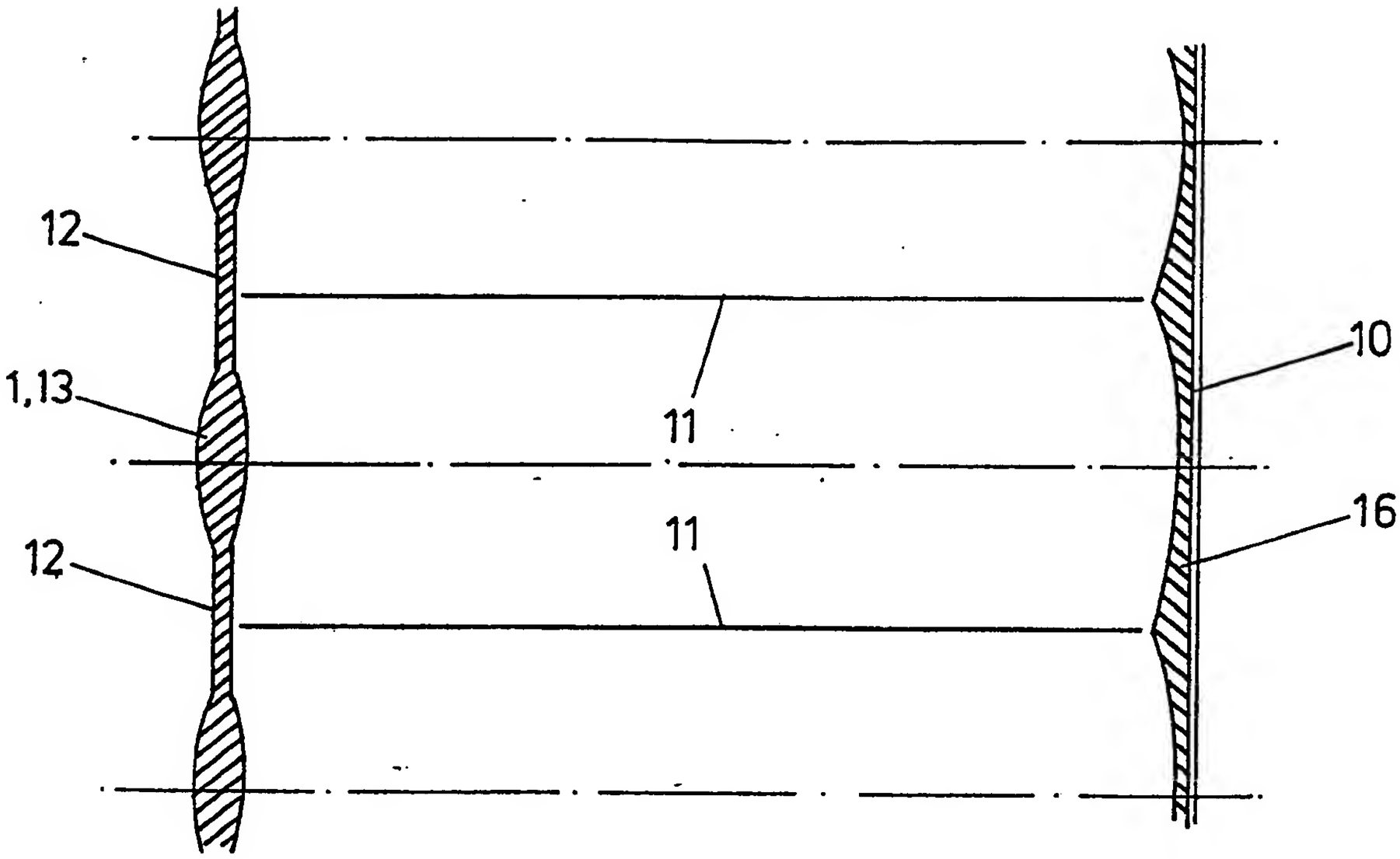

FIG. 6

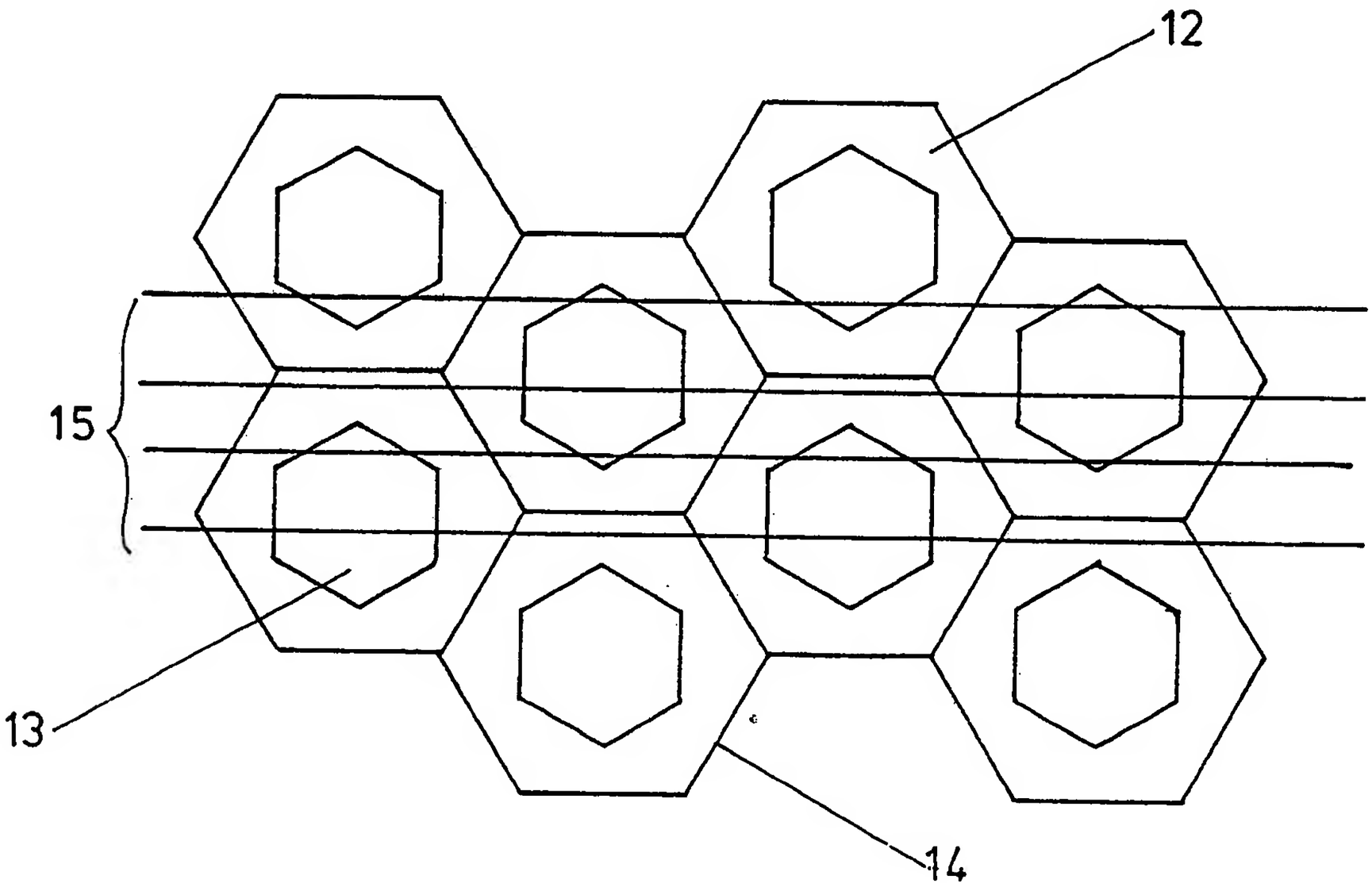

FIG. 7

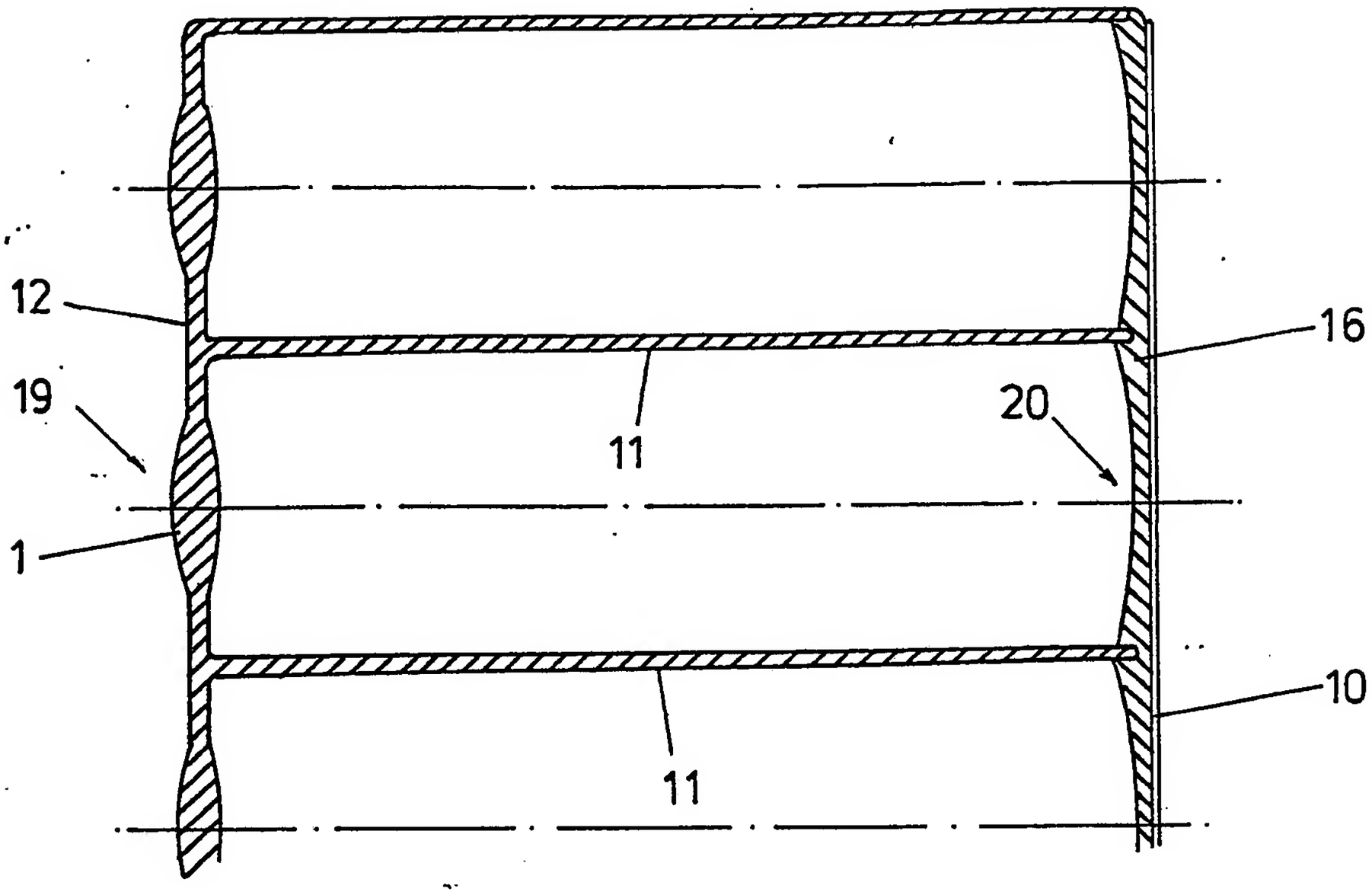

FIG. 8

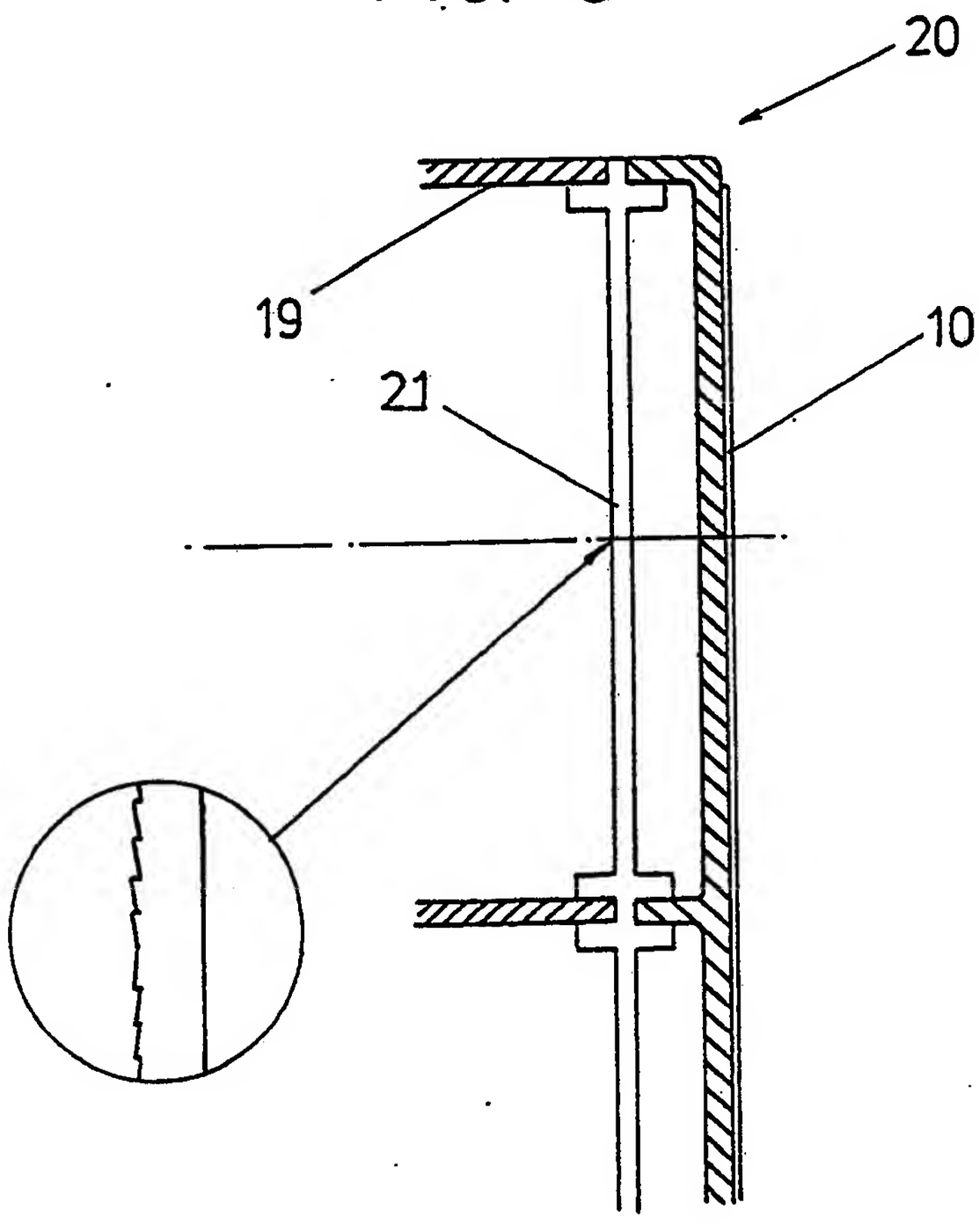

FIG. 9

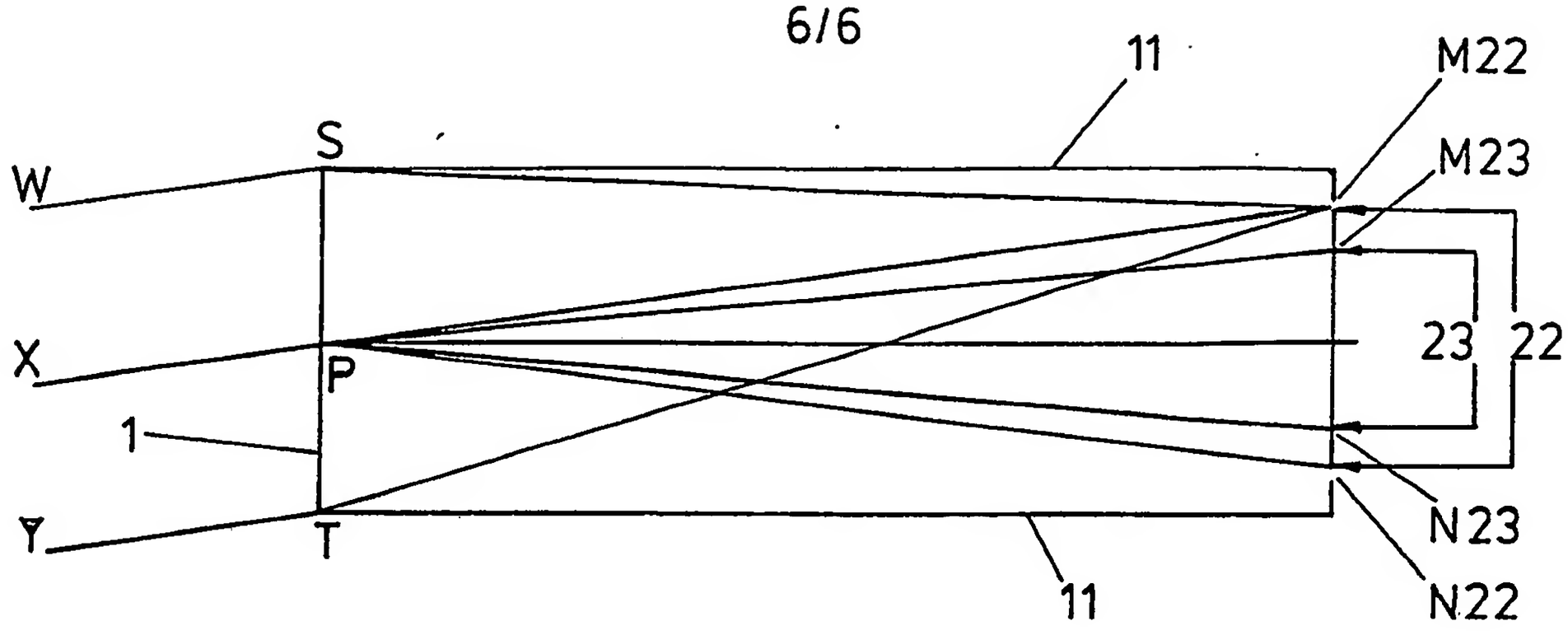

FIG. 10

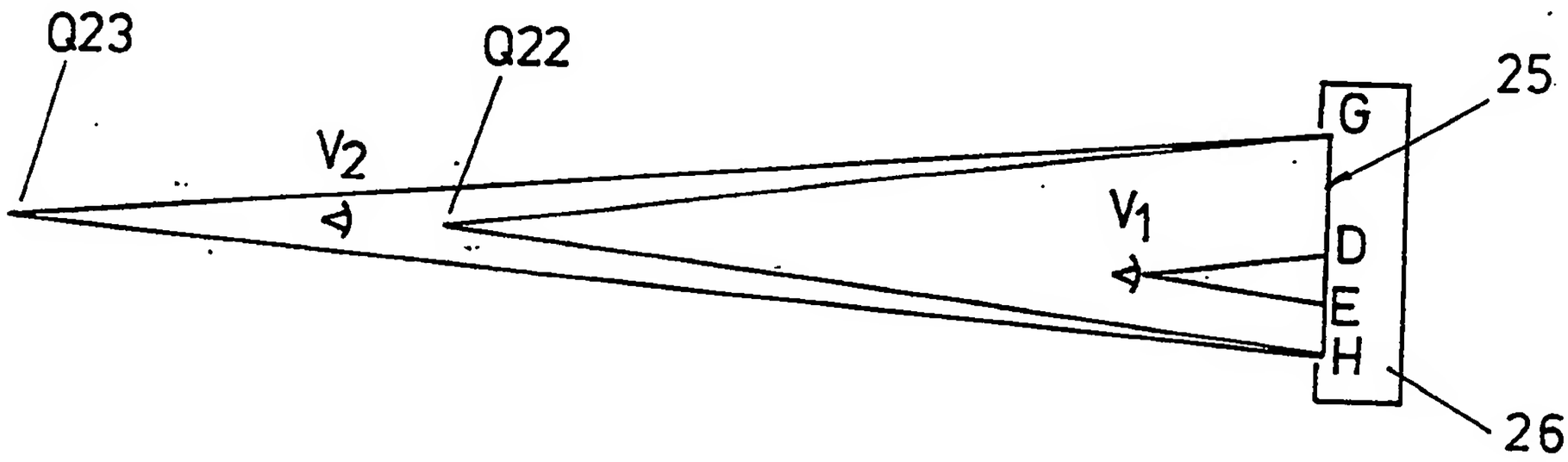

FIG. 11

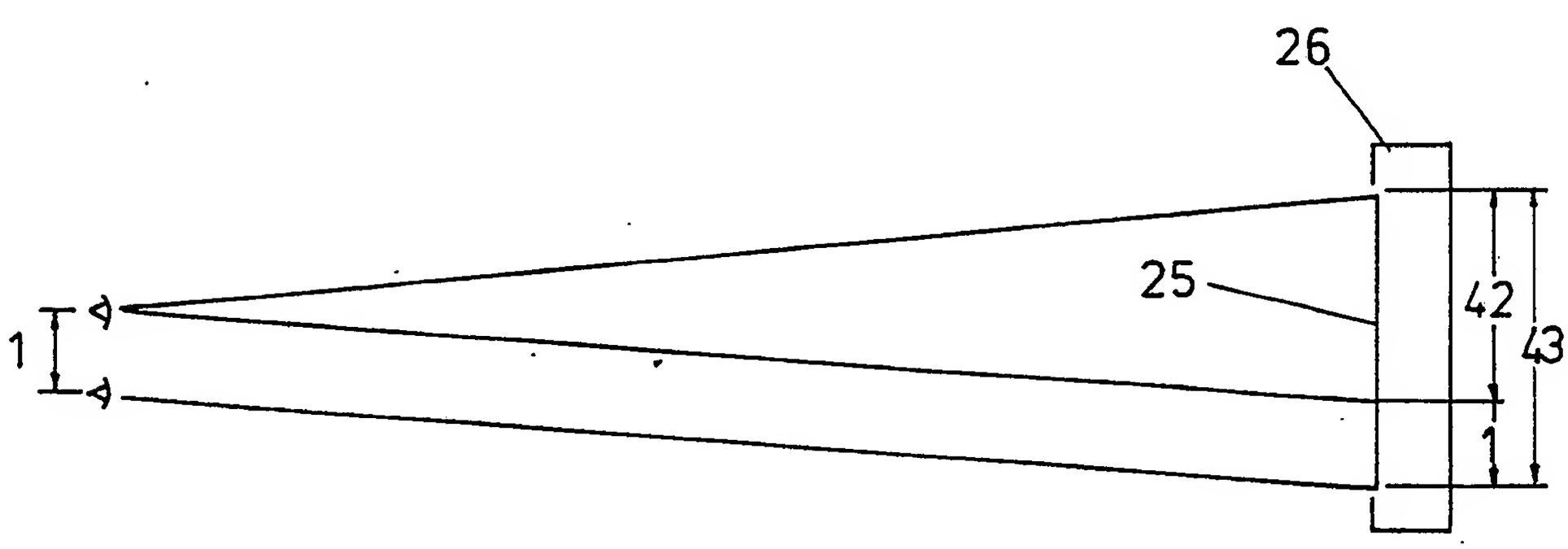

FIG. 12

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 89/00195

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: G 09 F 19/12; G 09 F 19/14; G 02 B 27/08

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	G 09 F; G 02 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US, A, 3568346 (TRAVERSIGN LTD) 9 March 1971 see claims 1-2; figures 4-7 cited in the application --	1
A	GB, A, 2149527 (CASSEL-SMITH LTD) 12 June 1985 see claims 1-2,4; page 2, lines 4-42; figures 1-5 cited in the application --	1,2,7,9
A	FR, A, 2599519 (J.-F. SALIERI) 4 December 1987 see the whole document ----------	1,7

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
9th June 1989	22 JUN 1989
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8900195 SA 27529

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 15/06/89
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3568346	09-03-71	None	
GB-A- 2149527	12-06-85	None	
FR-A- 2599519	04-12-87	None	